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Structural Transformation of Cereal Markets in Ethiopia

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ABSTRACT *We study cereal markets in Ethiopia over the last decade, a period that has been characterised by important local changes, including strong economic growth, urbanisation, improved road and communication infrastructure, and higher adoption of modern inputs in agriculture. These changes are associated with better spatial price integration as well as with significant declines in real price differences between supplying and receiving markets and in cereal milling and retail margins. In short, important improvements have occurred in Ethiopia's cereal marketing system. This is especially important because dysfunctional cereal markets were previously identified as an important cause of food insecurity in the country.*

1. Introduction

Given the importance of food in expenditures of households in developing countries, the functioning of food markets and their impact on food prices are closely watched by policy makers and consumers alike. High food marketing costs can push consumer prices up to unaffordable levels for vulnerable groups and further hamper farmers' incentives to invest in new production technologies. The interest in food markets has become even more prevalent since the recent global food crisis, during which food prices reached very high levels (Headey, Malaiyandi, & Fan, 2010).

Understanding food markets is especially relevant in Ethiopia, given the disastrous implications that poorly functioning food markets had on food security in the past, when food stocks were available in some parts of the country while widespread famine occurred in other parts (Gabre-Madhin, 2001a, 2012; Webb & von Braun, 1994).[1] Major reasons for historically poorly functioning food markets have included a lack of market information, poor road infrastructure and high transaction costs, and distress sales and lack of storage by small farmers (von Braun & Olofinbiyi, 2007; von Braun, Teklu, & Webb, 1998). Important changes have occurred in these areas in the last decade in Ethiopia, however. In this paper, we assess the extent to which these changes have affected cereal markets using primary data collected from wholesale markets and secondary data on cereal prices and margins. Further, we discuss five possible reasons for the market transformation and for the changes in cereal price margins over the period 2001–2011.[2]

We find that the period under study has been characterised by important changes in five possible factors affecting the functioning of cereal markets. First, fast economic and income growth is changing food demand. Second, urbanisation is leading to larger rural–urban food and cereal marketing flows. Third, investments in road infrastructure and a better organised transport sector have led to significant declines in real transportation costs. Fourth, the widespread availability of mobile phones has improved access to price information for a large number of players in the commercial circuit and has led, for some, to a different way of making commercial deals. Fifth, increased adoption of modern inputs and better access to extension agents have likely contributed to increased cereal supply.

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Price data collected over the last 10 years at wholesale and retail levels show that these changes are associated with significant declines in real margins of wholesale food prices between supplying and receiving markets over time, in real cereal milling margins as well as in retail margins. We find that cereal prices increased over the decade but that price levels were affected differently in different markets. For example, cereal deficit and vulnerable regions experienced lower price rises than other regions. Price integration between wholesale markets has also improved significantly over the period studied. The cereal marketing system thus appears to have undergone important changes in Ethiopia to the benefit of producers and consumers alike.

The contribution of this paper to the literature is twofold. First, we rely on unique primary data from major wholesale cereal markets in a poor agricultural economy and document the degree to which structural changes are taking place in the way that business is done in these markets. Second, we use price series to test for structural transformation in price relationships along different dimensions, such as space, form, quality, and marketing level. Such comprehensive assessments of changes in structural factors and food price relationships, based on unique qualitative and quantitative data, are rare in developing countries.

The structure of the paper is as follows. In Section 2, we discuss the data and the methods used. In Section 3, we empirically document the changes that likely contributed to structural transformation in the country and discuss economic and income growth, urbanisation and commercial surplus, roads, access to and use of communication technology by brokers and traders, and adoption of improved agricultural technologies. In Section 4, we look at spatial price variation, price integration, quality price premia, processing margins, and retail margins. We finish with the conclusions in Section 5.

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2. Data and Methodology

We rely on two main datasets – using primary as well as secondary data – for the analysis in the paper. The Ethiopian Grain Trading Enterprise (EGTE), a grain procurement arm of the government, gathers prices of cereals in 66 major wholesale markets in the country. Prices are collected during the early morning, late morning, and afternoon on major market days, and simple averages of these prices over the course of a month are reported as monthly prices. The prices are collected not by asking what price levels are, but by noting prices from observing actual transactions. Producer, wholesale, and retail prices[3] are all collected but only wholesale and retail prices at 12 selected markets are made available publicly. These price data were obtained in electronic form and are thus used in the analysis. Because the weights of individual cereals in the national Consumer Price Index (CPI) are relatively low, and due to a lack of any reasonable alternative, we rely on this national CPI as constructed by the Central Statistical Agency (CSA) to deflate prices.[4]

To complement the price data, a survey was conducted in 31 major cereal wholesale markets of the country in the beginning of 2012. The objective of this survey was to gather information about changes that have taken place in these markets over the last 10 years. Almost all major cities as well as the most important production areas are included in this survey.[5] The survey was conducted with focus groups of transporters and key informants for specific crops in the selected wholesale markets. The focus groups were comprised of respondents with significant experience in cereal trade in each market (as there were many recall questions). Questions were asked about the extent of changes in transport costs and travel times between different wholesale markets, changes in access to and the spread of mobile phones and the use of mobile phones in agricultural trade, and changes in the size of the market. Given that we only interviewed focus groups in those markets where these crops were deemed important (as indicated by the markets where EGTE collects prices for these crops), the total number of focus groups differs by crop. For example, there are 25 groups for teff, 16 for wheat, five for sorghum, six for barley, and 19 for maize, for a total of 71 focus groups. While the focus group interviews were carefully fielded and therefore give a good indication of changes over time, we acknowledge that focus group interview methods are prone to measurement error, and are especially so in the case of recall questions. Consequently we do not rely on statistical techniques that are based on sampling to test differences over time from the recall data.

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We look at several aspects of cereal price behaviour. First, we analyse quality premia and spatial margins. Using the EGTE wholesale price series, we estimate regression models that include temporal, spatial, and quality variables as explanatory variables. We use year-month fixed effects to control for all potential temporal variation.[6] These controls allow us to better estimate the issues of interest, that is quality and location. In estimating the standard errors, we allowed for clustering by quarter, and therefore for dependence between months. The regression used is as follows:

$$Log\,(real\ price\ of\ cereal\ grain\ i) = f(year * month,\ market\ location,\ quality) \tag{1}$$

Second, we study the processing and retail margins. To do this, we combine the wholesale prices with two other datasets. For the analysis of processing margins, we merge cereal flour price data collected by the CSA in retail markets with the wholesale cereal grain market prices. We only retain the prices for these markets and for those periods that are common to both datasets. For the analysis of the retail margins, we merge the wholesale prices with the prices collected by EGTE at the retail level. Unfortunately, these retail price data are only available until the end of 2009 and thus we have to limit our analysis to the period 2001–2009. We follow a similar method as explained above and the estimated regression is as follows:

$$Log\,(real\ price\ of\ cereal\ i) = f(year * month,\ market\ location,\ quality,\ grain/flour,\ retail/wholesale) \tag{2}$$

A major objective of the study is to evaluate the structural transformation of these markets. To understand if a structural break in these time series occurred in the last decade, we merge the different variables with a time dummy for the second part of the period studied (2006–2011). We then assess the significance of these coefficients and compare them to the coefficients in the first part of the decade (2001–2005) through an F-test. In the case of a significant difference, we conclude that a structural break occurred over the last decade. We present the results of these tests for spatial variation, quality premia, retail margins, and processing margins.

Third, we test the extent to which markets in Ethiopia are integrated. Following Van Campenhout (2007), we estimate threshold autoregressive (TAR) models, in which we allow the thresholds and adjustment parameters to vary over time in the following way:

$$\Delta d_t = \begin{cases} \rho_{out} d_{t-1} + \rho_{out} t d_{t-1} + \varepsilon_t & : d_{t-1} > \theta_t \\ \varepsilon_t & : -\theta_t \le d_{t-1} \le \theta_t \\ \rho_{out} d_{t-1} + \rho_{out} t d_{t-1} + \varepsilon_t & ; d_{t-1} < -\theta_t \end{cases}, \tag{3}$$

where d_t is the difference between the price in Addis Ababa and the regional wholesale market of interest (that is $d_t = p_{t,A} - p_{t,r}$, where $p_{t,A}$ is the market price in Addis and $p_{t,r}$ is the market price in regional markets at time t), $\Delta d_t = d_t - d_{t-1}$, ε_t is the estimated residual, t denotes the time trend, θ is an approximation for transaction costs, and ρ_{out} is the adjustment factor for prices outside of the transaction cost band (that is $-\theta$ *to* θ).

As in Van Campenhout (2007), we allow the threshold θ_t to vary over time in the following manner:

$$\theta_t = \theta_0 + \frac{(\theta_T - \theta_0)}{T}.t \tag{4}$$

The threshold can therefore vary from θ_0 at t = 0 to θ_T at t = T. We also report the speed of price adjustments in the price integration results. Following Van Campenhout (2007), this is the *half-life*, which is defined as the time needed for prices to return to half of their initial value following a shock from a long-run equilibrium. In other words, the half-life measures how fast errors are corrected, and is calculated as the solution for T in f(t+T) = f(t)/2, which is just T = ln(1/2)/ln(b), where in our case,

b = 1 + ρ. If, for example, ρ is –0.5, then T is one, which means that it takes one week to correct half the shock. In the limit, when ρ approaches –1, any shock in t–1 is fully corrected in t.

3. Possible Reasons for Structural Transformation in Cereal Markets

In the last decade, a number of structural changes have occurred in the overall economy as well as in the food economy of Ethiopia – on top of the changes in the international food markets (Headey et al., 2010) – that have affected cereal markets and price formation in the country. Given data constraints, it is impossible to estimate the exact effects of the changes of these different factors on food price formation and market transformation, but it seems clear that they have all had some impact.[7] These changes include economic and income growth, urbanisation and commercial surplus, transport and communication infrastructure, and agricultural technologies and extension, and we elaborate on them here.

Economic and Income Growth

Since 2004, Ethiopia has been one of the fastest growing economies in the world, which is a remarkable feat for a non-oil exporting African country. While growth of the GDP measured in constant market prices was negative in the beginning of the decade, it shot up from 2004 onwards and has stayed in double digits since. While it remains unclear how the benefits of economic growth were distributed among Ethiopia's population, the upshot is that such growth rates lead to significantly different consumption patterns for those who benefited from this growth. This has important implications for food markets.

To understand how food markets have been affected, we distinguish two effects of GDP growth: (i) how incomes of consumers are affected and (ii) how consumers change their consumption patterns because of increases in income. First, evidence from national household surveys suggests that consumption expenditures are increasing and that poverty levels are decreasing. Real per adult equivalent consumption in 2004/2005 (1,542 ETB at 1995/1996 constant prices) was 16 per cent higher than five years prior, and 17 per cent higher than 10 years earlier (MoFED, 2008). Kuma (2010) finds similar results in urban areas, where consumption expenditures grew by almost 15 per cent between 1994 and 2004. Analysis of the most recent national household data shows that poverty declined between 2004/2005 and 2010/2011 from 38.7 per cent to 29.6 per cent, indicating further welfare improvements over the period considered (MoFED, 2012).

Second, as incomes grows, consumption patterns are likely to change as households consume more high quality foods relative to lower quality foods. An indicator that this is taking place in Ethiopia in the presence of income growth is that income elasticities of demand for meat, fruits, and vegetables are considerably higher than for most cereals. Even among cereals, however, some, such as teff, have high demand elasticities, while others, such as sorghum and maize, have low elasticities (Tafere, Taffesse, & Tamiru, 2010). As such, it is not surprising that urban consumption patterns over the past decade have increasingly included more teff, milk and milk products, meat, and fruit (Kuma, 2010).

Urbanisation and the Increase in Commercial Surplus

Although it started from a low base, Ethiopia has experienced rapid urbanisation over the past couple of decades (Schmidt & Kedir, 2009). This trend is important for cereal markets as urban populations typically do not grow their own food, and instead rely on markets for their food needs. A consequence of growing urban areas therefore is an increasing flow of agricultural commercial surplus within a country.[8]

Based on data from the national census in 2007, Schmidt and Kedir (2009) estimate that 14.2 per cent of the Ethiopian population lived in urban areas, and that urban centres have grown by up to 3.7 per cent per year on average. Using these growth rates, the urban population grew by 44 per cent, or

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by 3.7 million people, over the period 2001–2011. To put that number into perspective, consider the following: Assuming that the average urban consumption level of cereals was as high as was estimated in the national household survey (HICES) of 2004/2005, and that the urban population relied completely on production shipped in from rural areas, commercial flows of cereals increased by about 500,000 tons between 2001 and 2011. This is equivalent to an additional 65,000 truckloads (of 7.5 tons in a widely used medium-sized Isuzu FSR truck) between rural and urban areas over the decade, or 650 additional trucks per year (assuming 100 cycles per truck). According to official statistics published by the CSA, there was indeed a large increase in the commercial quantities of cereals traded in the country over the last decade, as the commercial surplus for the five cereals together increased by an estimated 117 per cent over this 10-year period.[9]

Focus group participants in the wholesale market survey were asked about level and trends vis-à-vis numbers of traders and brokers in the markets, and of cereal trucks arriving in these markets. These numbers confirm that the commercial surplus has increased rapidly over the last decade. For example, significantly more trade is reported on average in these markets over time. The reported number of trucks increased over the 10 years by almost 70 per cent and by almost 80 per cent in the peak and lean periods, respectively. These growth rates are faster than the urban population growth rates in the country (Schmidt & Kedir, 2009), possibly indicating higher consumption levels in the cities over time, more trade between rural areas that might pass through these urban wholesale markets, and shifts from other means of transportation to trucks.

The focus groups' assessment of trends in the number of traders and brokers that operate in these markets also indicates considerable growth over time. With the number of traders perceived to be growing by almost 150 over the past decade, and the number of brokers growing by more than 250 per cent, competition appears to have become keener and turnover per trader and broker lower.

Roads and Transportation Costs

Several factors have contributed to changes in transportation costs over the last 10 years. In what follows, we review some of these factors, including changes in the road network and investments in road infrastructure improvements, increases in fuel costs, and changes in the types of trucks plying the roads.

First, since coming to power two decades ago, the Ethiopian government has embarked on a large road investment programme and the current level of infrastructure development in the country is unprecedented. For example, all-weather surfaced roads are in the process of being built or have already been built between the capitals of all regions. Further, the length of all-weather surfaced roads more than doubled in 15 years, from an estimated 19,000 km in 1993 to 44,300 km in 2008. This type of road development has important effects on the connectivity of agricultural markets in the country. Based on interviews with transporters in the wholesale market survey, asked about travel times between different wholesale markets in the country and the Addis wholesale market, transport times have fallen on average by 20 per cent over the last 10 years, from 10 hours to eight hours.[10]

Second, fuel prices have risen substantially over time. Until October 2008, the Ethiopian government subsidised fuel prices.[11] But with the abolition of fuel subsidies combined with the increase in international fuel prices, real fuel prices increased significantly. CSA retail price data indicate that the real price of diesel in the beginning of the decade was 60 per cent lower than at the end of the decade. Given that fuel is an important determinant of transport costs, this undoubtedly contributed to relatively higher transport costs over time.

Third, the increase in the number of larger capacity trucks plying the roads is putting downward pressure on transportation costs. This follows because the bigger the truck, the lower the per unit transport costs. As increasing quantities of food are being shipped between markets, it is becoming easier to fill larger loads in bigger trucks, and consequently there are greater incentives to enter into food trade with larger trucks. The wholesale market survey data indicate that this is indeed taking place. Over time, the importance of larger trucks (FSR; able to carry about 7–8 tons) has grown compared to smaller ones (regular Isuzu; carrying about 5–6 tons); the share of FSR trucks in the total number of trucks transporting cereals grew from about 15 per cent in 2001 to 33 per cent in 2011. The

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use of trailer trucks, able to transport 20 tons, is still limited and its share stayed constant over time. Overall they make up 13 per cent of the trucks that transport cereals (they are more important for longer distance journeys).[12,13]

Taken together, these three factors are likely to have affected transportation costs between wholesale markets in Ethiopia. To assess this, participants in the transporter focus groups were asked to estimate travel costs over the last 10 years for those trips that were commonly taken from the market in which they were interviewed. To allow for comparison over time, these prices were deflated by the CPI.[14] The results from recall data in focus group interviews indicate that the mean and median of transport costs fell significantly throughout the decade (estimated by focus groups to be about 50%, although this is admittedly a very rough estimate given that recall error for cost estimates is likely large in the presence of high inflation). The improvements in roads and the shift to bigger and cheaper trucks appear to have far outweighed the rise of fuel prices and have resulted in significantly lower real transportation costs between markets in the country.

Access to Mobile Phones

Mobile phones have become widely available in Ethiopia, allowing traders and farmers to exchange information more easily. The widespread availability of mobile phones in rural areas of developing countries has led to a number of beneficial effects on farmers and on the trade environment in general (for example, Aker & Fafchamps, 2014; Jensen, 2007). These effects may also benefit Ethiopian farmers and traders, given that at the time of the wholesale survey in early 2012, almost all traders and brokers in the survey used mobile phones in their business. Figure 1 shows how mobile phone coverage changed over time in the wholesale markets in the survey. In 2000, only the Addis Ababa market had mobile phone coverage, but that quickly changed and by the year 2005 there was almost universal coverage in these rural wholesale markets. Figure 1 further shows that mobile phone usage rates increased to 100 per cent for traders and brokers of all the cereal crops in the various markets within an average of only four to five years after the introduction of coverage.

To understand the impact of this rapid spread of mobile phones on cereal trade, further follow-up questions were asked of the focus groups. First, in order to better understand their access to

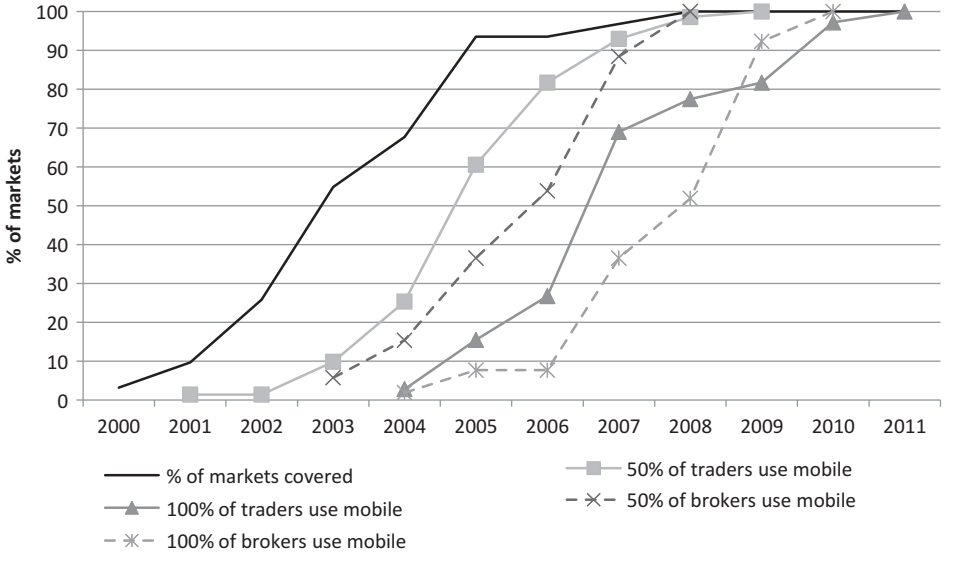

Figure 1. Mobile phone use by brokers and traders on wholesale markets, cumulative percentage over markets, 2000–2011.
Source: Authors' compilation from focus group interviews.

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Table 1. Use of mobile phones by traders and brokers

	Percentage of traders/brokers			
	Mean	Median	Mean	Median
Percentage of traders/brokers that had access to a fixed phone	now		before	
a. Traders				
… at home			46	50
… on the market			22	15
… at another location			62	75
b. Brokers				
… at home			11	5
… on the market			3	0
… at another location			56	65
Estimated number of phone calls per trader per day related to his trade business	by mobile phone		by fixed phone	
a. Traders				
… In the peak period	24	25	8	5
… In the lean period	8	8	2	2
b. Brokers				
… In the peak period	34	30	6	5
… In the lean period	11	10	2	2
Use of phone	'Are mobile phones used to…'?		'Were fixed phones used to…'?	
a. Traders				
'… inform/transmit prices'	86	99	47	50
'… agree on prices (plus quantity/quality) with sellers'	36	25	14	5
'… request a show-up (quantity requested but without price agreements) with sellers'	38	25	16	0
'… agree deals (prices and quantity) with transporters'	40	35	6	0
'… agree on prices (plus quantity/quality) with buyers'	46	45	19	10
'… request a show-up (quantity requested but without price agreements) with buyers'	38	25	19	10
'… follow-up payments with buyers/sellers'	81	100	31	25
b. Brokers				
'… inform/transmit prices'	59	75	20	15
'… agree on prices (plus quantity/quality) with sellers'	20	0	2	0
'… request a show-up (quantity requested but without price agreements) with sellers'	34	0	11	0
'… agree deals (prices and quantity) with transporters'	39	45	7	0
'… agree on prices (plus quantity/quality) with buyers'	20	0	6	0
'… request a show-up (quantity requested but without price agreements) with buyers'	36	0	12	0
'… follow-up payments with buyers/sellers'	45	30	13	0
Number of observations	71		71	

Source: Authors' compilation from focus group interviews.

communication technology over time, focus groups were asked to assess the percentage of traders and brokers who had access to fixed phones before mobile phones became available. The results, reported in Table 1, indicate that a large majority of these traders and brokers previously had some form of access to fixed phones (for example, at home, on the market, or at another location). Nearly half of the traders reported having a fixed phone at home before gaining access to mobile phones, indicating that mobile phones did not fill a complete communications void, as experienced in other countries.

Second, while telephone communications existed prior to the introduction of mobile phones, mobile phone technology has improved the ease of access to communications, as evidenced by the frequency of phone use. According to the focus groups, an average broker now makes 34 business calls per day during the peak trading period, while traders make 24. This is roughly three to six times more than the

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number of calls made using fixed lines prior to the introduction of mobile phones. It is also worth noting that the number of calls made with mobile phones drops off significantly in the lean period, reflecting the important seasonality in traders' and brokers' business activities.

Third, questions regarding the purpose for using mobile and fixed-line phones indicate that almost all traders and brokers today use mobile phones to transmit prices, compared to roughly half who did so previously with fixed lines (Table 1). Thirty-eight per cent of the traders and 34 per cent of the brokers use mobile phones to request a show-up with the product at the market. Fewer use phones to agree on prices with sellers and buyers. Given the lack of standards in Ethiopia, this is likely due to buyers wanting to inspect the produce personally before making a deal. A large majority of traders use phones to follow up on payments of traders and buyers. This number is much lower for brokers, possibly because their transactions are less likely to involve the extending of credit. Compared to the situation before mobile phones were introduced, it is clear that more information is obtained and more deals are struck by phone. Indeed, more than twice as many traders and brokers use their mobile phones today for conveying price information and for making deals with sellers, buyers, and transporters than did so with fixed-line phones when they were all that was available.

Finally, focus group participants were asked subjective questions about how the situation in trade has changed since mobile phones were introduced. While it is highly unlikely that mobile phones were the sole cause of the changes reported by the focus groups, they likely did contribute significantly in some way. Most of the traders and brokers report interacting with more sellers, buyers, and transport brokers before making deals. Since physical location of the market matters less with mobile phone technology, traders and brokers appear to be bypassing wholesale markets in rural areas and in Addis Ababa. While the wholesale markets are not completely bypassed, the focus groups report that in rural areas this is occurring to some extent in 94 (88) per cent of the markets for traders (brokers). Furthermore, 61 (66) per cent of the trader (broker) focus groups report bypassing the Addis Ababa wholesale market. The traditional role that Addis Ababa has played as a clearinghouse in the cereal trade in Ethiopia, because of its central geographical location and the lack of alternative roads (Gabre-Madhin, 2001a), may therefore slowly be changing due to easier access to information and the improved road network.

Agricultural Technology and Agricultural Extension

A number of changes have taken place in the last decade that have led to increases in agricultural production. While much of the increased production appears to be driven by the expansion of cultivated land (Dercon & Hill, 2009; Taffesse, Dorosh, & Gemessa, 2013), and while the adoption of improved agricultural technologies in the country is rather low, there are some indicators that bode well for increased productivity. Foremost among these are the increasing availability and adoption of improved modern technologies and the widespread placement of extension agents. Admittedly though, those in better-connected areas appear to have greater access to these technologies and services (Minten, Tamiru, Engeda, & Kuma, 2013).

First, although adoption rates for improved cereal seeds are low (as shown in official statistics), these rates are, however, an underestimate and adoption has seemingly improved over the last decade (Spielman, Kelemwork, & Alemu, 2011). The use of improved seeds is primarily found in the case of maize and wheat (Spielman et al., 2011), though the adoption of an improved teff (*quncho)* seed variety accelerated in the latter part of the decade (Minten et al., 2013). Second, fertiliser consumption in Ethiopia grew from 140,000 tons in the early 1990s to about 650,000 tons in 2012, and the area dedicated to cereal production that was fertilised more than doubled over the last decade (Rashid, Tefera, Minot, & Ayele, 2013). Third, the Ethiopian government has invested heavily in the expansion of the agricultural extension system. At the end of decade, the government had placed 45,000 extension agents in villages, compared to 2,500 and 15,000 extension agents in 1995 and 2002, respectively (Davis et al., 2010). With a target of three extension agents per *kebele*, Ethiopia has one of the largest extension agent–farmer ratios found in the world today (Davis et al., 2010).[15]

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Table 2. Changes in structural factors in the last decade

Driver – Measure	Number of obs.	Average 2001–2005	Average 2006–2011
1. Economic growth			
– GDP per capita (constant 2005 USD, PPP)	10	6.7	10.6
2. Urbanisation/commercial surplus*			
Cereal trucks per week arriving….			
– … in peak period	31	37	50
– … in lean period	31	15	21
3. Roads and transportation costs**			
– time taken to travel between markets (hours)	205	9.6	8.4
– real transportation costs between cereal wholesale markets (constant 2010 costs; ETB/quintal per trip)	205	128	79
4. Mobile phones***			
Share of markets (%) where at the end of the period ….			
– … 100% of traders are using mobile phone	71	15	100
– … 50% of traders are using mobile phones	71	61	100
– … 100% of brokers are using mobile phone	71	8	100
– … 50% of brokers are using mobile phones	71	37	100
5. Agricultural technology			
– Share of cereal land with improved seeds	10	5	5
– Share of fertilised cereal land	10	47	51

Source: Authors' compilation from (1) World Bank macro-economic data; (2), (3) and (4) focus group discussions; (5) CSA agricultural sample surveys.
Notes: *31 observations reflecting the 31 markets visited; **the 205 observations reflect the major effective product flows of the 31 surveyed wholesale markets with the other major wholesale markets (time and costs were only asked for those markets where there was an effective flow); ***71 crop focus groups (25 teff; 16 wheat; five sorghum; six barley; 19 maize).

We summarise this section with an overview, in Table 2, of the possible drivers of structural transformation in Ethiopia's cereal markets and how they have changed over the past decade. We see important changes in all cases.

In short, the evolving drivers of structural change in cereal markets are likely to manifest themselves in a number of predicted outcomes. For example, increasing urbanisation, increasing supply, and income growth will likely lead to more quantities traded and greater economies of scale, and thus to lower margins overall. In addition, access to better price information should lead to a more efficient marketing system, and consequently lower overall margins. Finally, changes in food consumption patterns due to income growth may be reflected in higher quality premia if changes in the supply of high quality products do not keep pace with the growing demand for these products. In the next section, we empirically address these questions. In particular, we analyse spatial price variation, spatial market integration, quality premia, and margins (processing and retail).

4. Cereal Price Behaviour

Spatial Price Variation

Ethiopia is characterised by a very diverse agroecology, which results in spatial specialisation and in different agricultural production and consumption patterns across the country (Chamberlin & Schmidt, 2011; CSA, EDRI, & IFPRI, 2006). To better understand the spatial flows of cereals in the country, the focus groups in the wholesale markets were asked questions about trucks arriving in and departing from their markets, and about the types of loads they carry. Using this information, it is possible to identify areas in Ethiopia that supply and receive cereals. These data on cereal market flows indicate that areas in the west (maize) and south (barley, wheat) are the major suppliers of cereals. Addis Ababa

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and areas in the east (Dire Dawa) and the north (Mekelle), on the other hand, are cereal deficit areas (Gabre-Madhin, 2001a; Gelan & Dinka, 2006) and consequently receive grain shipments from the suppliers in the west and south of the country. The supply base for teff is more diversified than for other cereals, but major demand comes from Addis Ababa, Dire Dawa, and Mekelle, three of the most important cities in the country.

To test the degree to which these flows are reflected in wholesale market price differences, we compare the prices of different markets to the Addis Ababa market (the default market) using the model described in Equation (1). Since the dependent variable (real price of cereal *i* in market *j*) is expressed in logs, the reported coefficients for the market dummies in Table 3 show the relative difference in real prices compared to the Addis Ababa market (the left out category). In a second specification, we test for structural changes by effectively splitting the analysis period in two parts (2001–2005 and 2006–2011). This is done by including a dummy for the latter period separately

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Table 3. Regional wholesale price differences compared to Addis Ababa (results of coefficients of regression)

		Dummy time	Teff		Wheat		Maize		Barley	
†	Market	interaction	Coeff.	t-value	Coeff.	t-value	Coeff.	t-value	Coeff.	t-value
1	Ambo	none	**–0.05**	–5.61	**–0.14**	–10.19	**–0.08**	–5.87	**–0.06**	–3.42
	Assela	none	**0.02**	3.17	**–0.09**	–7.26	**0.14**	12.92	**–0.10**	–6.76
	Bale Robe	none	**0.08**	4.77	**–0.24**	–11.36			**–0.49**	–12.09
	Dessie	none	**0.04**	3.13	**0.06**	2.51	**0.06**	4.79	0.01	0.68
	Dire Dawa	none	**0.12**	7.49	**0.19**	6.74	**0.27**	3.89	**0.15**	7.52
	Gondar	none	0.00	0.29	**0.11**	4.89	**0.06**	3.36	**0.23**	10.43
	Jimma	none	**–0.04**	–3.35	**0.06**	3.23	**–0.15**	–2.76	**0.04**	2.10
	Mekelle	none	**0.08**	7.58	**0.18**	6.16	**0.18**	8.77	0.12	1.55
	Nazreth	none	0.00	0.28	0.00	0.01	–0.01	–0.48	**–0.06**	–4.39
	Nekemt	none	**–0.14**	–16.96	–0.01	–1.08	**–0.19**	–9.36		
	Shashemene	none	–0.01	–0.48	**–0.06**	–5.90	**–0.04**	–3.60	–0.09	–4.89
2	Ambo	2001–2005	**–0.06**	–5.27	**–0.16**	–8.24	**–0.10**	–4.44	–0.03	–1.29
	Assela	2001–2005	**0.03**	2.51	**–0.12**	–7.56			**–0.14**	–7.61
	Bale Robe	2001–2005	0.03	1.18	**–0.32**	–10.02			**–0.49**	–7.26
	Dessie	2001–2005	**0.09**	3.97	**0.09**	2.60	**0.09**	3.82	**0.06**	2.43
	Dire Dawa	2001–2005	**0.18**	7.13	**0.26**	6.26	**0.39**	2.69	**0.22**	7.49
	Gondar	2001–2005	**0.08**	7.91	**0.21**	7.77	**0.10**	4.14	**0.33**	13.05
	Jimma	2001–2005	**–0.04**	–3.74	**0.05**	2.44	–0.20	–1.04	0.04	1.84
	Mekelle	2001–2005	**0.13**	13.38	**0.24**	6.54	**0.26**	9.13	**0.32**	5.90
	Nazreth	2001–2005	**0.02**	2.05	–0.00	–0.17	0.02	0.30	**–0.04**	–2.08
	Nekemt	2001–2005	**–0.17**	–13.01	0.02	0.87	**–0.23**	–7.53		
	Shashemene	2001–2005	–0.03	–1.60	**–0.07**	–7.52	**–0.06**	–3.11	**–0.09**	–3.80
3	Ambo	2006–2011	**–0.04**	–3.16	**–0.11**	–7.55	**–0.06**	–4.17	**–0.10**	–3.45
	Assela	2006–2011	**0.02**	2.01	**–0.07**	–4.28	**0.13**	14.44	**–0.07**	–3.70
	Bale Robe	2006–2011	**0.12**	6.03	**–0.18**	–9.72			**–0.47**	–25.43
	Dessie	2006–2011	0.00	0.34	0.02	0.78	**–0.04**	3.62	–0.03	–0.87
	Dire Dawa	2006–2011	**0.07**	6.30	**0.10**	6.34	**0.17**	10.21	**0.08**	5.59
	Gondar	2006–2011	**–0.05**	–4.08	0.03	1.28	0.03	1.32	**0.16**	6.18
	Jimma	2006–2011	–0.04	–1.92	**0.06**	2.09	**–0.14**	–3.93	0.04	1.29
	Mekelle	2006–2011	**0.04**	3.52	**0.12**	3.16	**0.12**	5.99	**–0.15**	–3.26
	Nazreth	2006–2011	–0.01	–1.47	–0.00	–0.38	–0.03	–1.69	**–0.08**	–4.56
	Nekemt	2006–2011	**–0.12**	–13.54	**–0.04**	–2.54	**–0.15**	–6.45		
	Shashemene	2006–2011	0.01	0.92	**–0.06**	–3.65	**–0.03**	–2.01	**–0.07**	–2.73

Source: Authors' calculations.
Notes: †model specification. Addis is the default market in all specifications. Shaded values represent statistically significant differences at the 5 per cent level between the 2001–2005 and 2005–2011 periods from that market to major supplying areas, the coefficients of which are underlined (teff; Ambo; wheat: Bale Robe; maize: Nekemt; barley: Shashemene). Coefficients in bold are significant at the 5 per cent level. Robust White standard errors to within cluster (by quarter) correlation.

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and merging it with all of the other coefficients in the model. The Addis Ababa market in the first and second period are therefore the default markets. Our test for structural change follows from comparing price differences in the first period to those in the second period (significant changes are highlighted in grey in Table 3). In particular, we are interested in price changes from the major supplying areas to the other markets.[16] Significant changes at the 5 per cent level over the period are shaded in the Table.[17]

Three salient points follow from the results that appear in Table 3. First, while Addis Ababa is the biggest city in the country, cereal prices are not always the highest there. For example, prices tend to be higher in cereal deficit areas such as the eastern city of Dire Dawa, where the prices of all cereals are between 12 per cent (teff) and 27 per cent (maize) higher than in Addis Ababa (see top panel of Table 3). In the northern cities of Mekelle and Dessie, three out of four cereals are significantly more expensive than in Addis Ababa.[18] The only exception is the case of barley, where the difference is not significant at the 5 per cent level. On the other hand, cereal prices in major supply areas tend to be lower than in Addis Ababa. This is the case, for example, in the markets of Shashemene and Nekemt, which are both located in major cereal production zones. In short, price differences in the country generally reflect quite well the perceived flow of products throughout the country.

Second, we see that there are substantial changes in the relative ratios between the first and second halves of the decade (see the bottom two panels of Table 3), possibly reflecting the effective changes in transport costs between wholesale markets. For example, differences in teff and wheat prices relative to major supply area declined significantly for 5 and 11 of the 11 markets, respectively. For maize and barley, significant reductions were observed in four out of nine and in five out of eleven markets, respectively. For two major demand 'sinks', Mekelle and Dire Dawa (after Addis Ababa the two biggest cities in the country), price differences relative to Addis Ababa fell for all of the cereals (significantly for seven of the eight). For example, while the price of maize was 39 per cent and 26 per cent higher in Dire Dawa and Mekelle in the period 2001–2005, these differences declined to 17 per cent and 12 per cent, respectively, for the period 2006–2011. Similar changes took place with respect to differences between supply areas and Addis Ababa (see the supply markets with negative coefficients in Table 3), but to a lesser extent (the decreases were significant for two out of four cereals). Note that this is occurring despite a lack of infrastructure improvements for some of the supplying areas, such as Nekemt, where price differences have nonetheless fallen significantly for teff and maize. On the other hand, for some cereal supply regions, major infrastructure improvements have taken place and have translated into large declines in relative prices. For example, the price difference for wheat between Bale Robe and Addis Ababa fell from 32 per cent in the 2001–2005 period to 18 per cent in the 2006–2011 period. Similar declines are noted for Assela, a major producing area for wheat and barley.

Third, the variation in price differences among the wholesale markets with respect to the Addis Ababa markets declined over time. The difference between the highest and the lowest price differences in the first half of the decade compared to the second half declined by 11, 28, 30, and 19 percentage points for teff, wheat, maize, and barley, respectively.

Spatial Price Integration

The degree to which cereal prices move together across markets throughout Ethiopia (that is, how well they are integrated) provides a measure of how well these markets function. Thus we analyse the integration of wholesale markets by studying various market pairs for each of the major cereals using the TAR model described in Equation (3). In particular, we pair Addis Ababa with the four to six most important regional wholesale markets for each of the cereals, thus reflecting major cereal flows in the country.[19]

Three important results stem from this market integration analysis (Table 4). First, there has been an improvement in market integration over the past decade. In the aggregate, 33 per cent more markets were integrated in 2011 than in 2001.[20] Furthermore, all of the most important markets for mixed teff, red teff, and maize were well integrated at the end of 2011, while only half were in 2001. Eighty-three

Table 4. Degree of market integration of Addis Ababa with other cereal wholesale markets between 2001 and 2011

	Year	White teff	Mixed teff	Red teff	White wheat	Maize	White sorghum	Mixed barley
Total market pairs		6	6	6	6	6	4	4
Percent integrated markets	2001	50	50	50	67	50	50	50
	2011	83	100	100	83	100	50	75
Number of pairs where coeff. time trend sign. at 5% level		2	3	3	3	3	2	2
Half-life of adjustment to price	2001	4	12	9	11	6	28	49
changes (in weeks)	2011	3	6	7	6	4	25	8
Transaction cost (measured in	2001	9	8	15	33	45	19	33
per cent of the cereal price in that period)	2011	8	7	8	16	17	27	31

Source: Authors' calculations.

per cent of the regional white teff and white wheat markets were integrated with respect to the Addis Ababa market in 2011, compared to 50 per cent and 67 per cent, respectively, in 2001. While the improvement is not as dramatic for mixed barley, nonetheless 75 per cent of markets for this cereal were integrated in 2011 compared to 50 per cent in 2001.

Second, the speed of price adjustments has also improved considerably. This is illustrated in the average half-life of adjustment to price changes, which declined from an average of 17 weeks in 2001 to eight weeks in 2011. In other words, it now takes less than half the time for prices between wholesale markets to adjust halfway from deviations in long-run equilibrium prices than it did in 2001.

Third, the transaction costs between markets estimated in the TAR model (that is, the thresholds) fell for all cereals, with the exception of white sorghum. Indeed, the declines have been substantial, averaging nearly 50 per cent for all cereals (except sorghum) between 2001 and 2011.[21] We note that sorghum is not widely consumed in major markets such as Addis Ababa. As such, the thin sorghum markets with limited flows among them appear to be reflected in the estimation results.

Quality Premia

When consumers get richer, they demand more high quality food products. This often implies an increase in quality premia for such products (Vandeplas & Minten, 2011). To assess if this is occurring in Ethiopia, we use the EGTE wholesale market price data to examine the levels of and trends in quality premia at the national level and in Addis Ababa. Our measure of quality is the colour of the grain, which is the only quality information available in the data. Although colour is often only one characteristic of quality for cereals, Bekele and Ayele (2006) and Minten et al. (2013) find that it is an especially important determinant of quality premia paid in the Ethiopian market place.

The results of the regression analysis on price premia (from Equation (1)) and their evolution over time, in Table 5, illustrate two points. First, quality premia do exist in the Ethiopian markets, in that *white* cereals all command a premium over *mixed* cereals (or red in the case of teff). These premia range from 9 per cent for white wheat over mixed wheat, to 14 per cent for white barley over mixed barley, and to 27 per cent for white teff over red teff in the national market. The price premia paid in Addis Ababa are general higher than in other markets, but not uniformly. Second, the quality premia change surprisingly little over time. In none of the cases are the changes between the first and second halves of the decade significant. Moreover, with the exception of sorghum in national markets, the quality premia paid by consumers are stable or declining. This may indicate that suppliers are responding to price signals and that supplies of higher quality cereals are keeping up with the increases in demand.

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Table 5. Quality premia of cereals

		Overall		Period 2001–2005		Period 2006–2010		F-test structural change	
	Compared to	Coeff.	t-value	Coeff.	t-value	Coeff.	t-value	F-value	Prob > F
All markets									
Teff									
Mixed teff	White teff	**–0.12**	–18.57	**–0.12**	–11.20	**–0.12**	–15.20	0.00	0.99
Red teff	White teff	**–0.27**	–24.52	**–0.28**	–14.27	**–0.26**	–22.42	1.14	0.29
Barley									
Mixed barley	White barley	**–0.14**	–18.93	**–0.15**	–10.62	**–0.13**	–13.63	1.34	0.25
Wheat									
Mixed wheat	White wheat	**–0.09**	–11.34	**–0.09**	–10.01	**–0.09**	–7.87	0.05	0.82
Sorghum									
Mixed sorghum	White sorghum	**–0.15**	–14.05	**–0.12**	–6.39	**–0.16**	–10.94	2.63	0.11
Addis Ababa									
Teff									
Mixed teff	White teff	**–0.11**	–9.43	**–0.12**	–6.58	**–0.11**	–6.80	0.36	0.55
Red teff	White teff	**–0.32**	–17.54	**–0.33**	–10.13	**–0.32**	–15.15	0.16	0.69
Barley									
Mixed barley	White barley	**–0.19**	–9.56	**–0.22**	–7.18	**–0.16**	–7.24	2.46	0.12
Wheat									
Mixed wheat	White wheat	**–0.11**	–7.43	**–0.12**	–7.31	**–0.09**	–4.00	0.87	0.36
Sorghum									
Mixed sorghum	White sorghum	**–0.11**	–8.14	**–0.13**	–6.24	**–0.09**	–6.20	2.29	0.13

Source: Authors' calculations.
Notes: Coefficients in bold are significant at the 5 per cent level. Robust White standard errors to within cluster (by quarter) correlation.

Processing Margins

Part of the supply chain that affects the transmission of prices from producers to consumers is the processing sector. To analyse how processing and milling margins have changed as part of the structural transformation of cereal markets in Ethiopia, we compare the prices of milled products such as flour to the wholesale grain prices, as described in Section 2. By testing the extent to which prices of processed products changed over time relative to raw materials, we effectively test the changes in processing margins. We conduct these tests using the model described in Equation (2) for the Addis Ababa market as well as for all wholesale markets for which retail price data are available. In general, we find that flour margins are declining over time for all four cereal products in the analysis (Table 6), though the change in wheat (at the national level) and maize margins are not statistically significant. This result might reflect an improvement in the milling sector.

Changes in the milling sector are confirmed by secondary data from the Addis Ababa Trade and Industry Office Database. For example, the number of mills in the capital city has increased substantially over the last decade. While there was less than one mill per ward (*kebele*) on average in the middle of the decade, by 2011 there were five. Although part of this increase is likely due to increased formalisation of the milling sector and consequently more previously informal mills now being recorded in the data, this is unlikely to explain the entire increase. A consequence of this growing number of mills may be an increase in competition and a relative reduction in milling costs. Retail data collected by the CSA indicate that this may indeed be the case, since the real price charged for milling cereals at the end of 2010 was 50 per cent lower than it was a decade earlier.

Retail Margins

The final link in the supply chain affecting the transmission of prices from producers to consumers is at the retail level. To estimate the changes that have taken place at the retail level, we analyse retail margins by

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Table 6. Premium of flour over grain (measured as prices of flour retail to grain wholesale)

	Overall		Period 2001–2005		Period 2006–2010		F-test structural change	
	Coeff.	t-value	Coeff.	t-value	Coeff.	t-value	F-value	Prob > F
All markets								
Teff	**0.22**	13.62	**0.29**	19.76	**0.15**	7.90	**44.43**	0.00
Barley	**0.45**	5.18	**0.67**	10.73	**0.38**	4.28	**10.62**	0.00
Wheat	**0.48**	20.41	**0.49**	16.68	**0.47**	15.70	0.21	0.65
Maize	**0.59**	15.69	**0.59**	12.54	**0.59**	13.85	0.00	0.99
Addis Ababa								
Teff	**0.31**	13.15	**0.37**	12.61	**0.24**	7.46	**10.89**	0.00
Barley	0.08	1.45	**0.27**	2.70	0.03	0.99	**5.09**	0.03
Wheat	**0.46**	11.58	**0.49**	10.81	**0.33**	6.66	**5.33**	0.03
Maize	**0.70**	10.43	**0.75**	8.83	**0.58**	8.15	2.37	0.13

Source: Authors' calculations.
Notes: Coefficients in bold are significant at the 5 per cent level. Robust White standard errors to within cluster (by quarter) correlation.

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using data that EGTE collect on retail pricing and merging them with their wholesale price series. These retail price data are collected from traders who operate in or close to the wholesale market and who sell directly to consumers. In many cases, however, these retail traders are also involved in wholesale activities.

Before we discuss the results of the analysis, we highlight two caveats with respect to the EGTE retail price data. First, these retail data are only available up to the end of 2009. We therefore limit the retail margin analysis to comparisons between the 2001–2005 and 2006–2009 periods. Second, the retail data collected are not representative of the entire retail sector in the cities, because the data are only collected for those particular retail agents near to or in the wholesale markets. As such they do not include retailers elsewhere in the cities, nor do they include the amalgam of retailers who supply cereals through their shops or supermarkets, or especially through small mills. Nonetheless, despite these drawbacks, the data provide indications about the sizes of retail margins and how they evolve over time.

Three relevant findings emerge from the retail margin regressions (in Table 7) for Addis Ababa and for all the markets for which the data were available. First, retail margins in Addis Ababa are

Table 7. Retail margins for cereals

	Overall		Period 2001–2005		Period 2006–2009		F-test structural change	
	Coeff.	t-value	Coeff.	t-value	Coeff.	t-value	F-value	Prob > F
All markets								
Teff	**0.016**	14.71	**0.018**	12.69	**0.014**	9.41	**4.12**	0.05
Barley	**0.048**	19.20	**0.055**	18.13	**0.039**	20.69	**22.22**	0.00
Wheat	**0.044**	19.52	**0.050**	17.21	**0.036**	16.64	**15.11**	0.00
Sorghum	**0.026**	5.54	**0.034**	7.27	0.016	1.98	3.60	0.07
Maize	**0.049**	11.05	**0.040**	6.10	**0.060**	9.00	3.86	0.06
Addis Ababa								
Teff	**0.043**	10.62	**0.056**	10.64	**0.028**	13.11	**24.52**	0.00
Barley	**0.098**	7.89	**0.135**	8.47	**0.054**	7.62	**21.75**	0.00
Wheat	**0.090**	9.07	**0.122**	11.04	**0.050**	8.43	**32.67**	0.00
Sorghum	**0.076**	4.00	**0.120**	10.49	0.023	0.70	**7.71**	0.01
Maize	**0.105**	8.48	**0.128**	7.44	**0.078**	6.83	**5.99**	0.02

Source: Authors' calculations.
Notes: Coefficients in bold are significant at the 5 per cent level. Robust White standard errors to within cluster (by quarter) correlation.

significantly higher than in the rest of the country. This is not surprising, however, given the higher retail costs associated with a large city the size of Addis Ababa (for example, real estate costs and higher labour costs).[22] Second, margins differ by crop. Teff, for example, is characterised by the lowest margin, while maize has the highest. This might partly reflect the higher value of teff compared to other crops, while the difference in absolute retail margins between the other cereals is significantly smaller, possibly reflecting the fixed costs of retailing cereals (Gardner, 1975). Third, retail margins have generally fallen over time. In eight out of the ten changes tested, the decline is significant. Further, cereal margins declined significantly for all five cereals in Addis Ababa. Indeed, the average retail margin for cereals fell by half in the capital city.

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5. Conclusions

This study of Ethiopian cereal wholesale markets in the last decade (2001–2011) is important for three reasons. First, cereals make up almost half of the expenditures of consumers in Ethiopia and about three-quarters of the land area under cultivation in the country. Any price and market changes thus have important welfare and food security implications. Second, poorly functioning cereal markets have in the past been identified as a major cause of food insecurity. Third, because the explicit purpose of several government plans over the last decade[23] has been to stimulate agricultural market transformation, an evaluation of market changes is an important first step in understanding the impact of such government programmes. To better understand the structural transformation taking place in Ethiopian cereal markets, we examine possible reasons for changes as well as changes themselves in terms of cereal price behaviour. This is accomplished by using a unique wholesale market survey that was fielded in the beginning of 2012 and by using monthly price data in major wholesale markets throughout the country.

The five identified reasons for change over the past decade are economic growth, urbanisation, improved roads, greater access to information technologies, and better agricultural technology adoption. First, economic growth has been substantial over this period, and has likely resulted in household income growth and changes in food demand patterns. Second, urbanisation has increased rapidly, as 3.7 million more people are estimated to be living in urban settings than a decade ago. Given that urban dwellers are much less likely to grow their own food, this implies that commercial surplus has increased significantly over the last 10 years. Third, the government has invested heavily in improved road infrastructure in the last decade. We find that travel costs and travel times have decreased substantially over this time, possibly also driven by more competition and a shift to better and bigger trucks. Fourth, mobile phones are now universally being used by brokers and traders alike. Access to mobile phones changes price transmission between traders, farmers, and brokers in important ways. More deals are struck by phone and traders have begun to bypass wholesale markets entirely. It is also possible that the spread of mobile phones has led to more entry into trade as the information-based barriers to entry are removed. Fifth, increasing adoption of modern inputs and the more widespread presence of extension agents may have also led to increased agricultural supply.

The evolving drivers of structural change in cereal markets are likely to manifest themselves in a number of predicted outcomes. For example, increasing urbanisation, increased supply, and income growth will likely lead to more quantities traded and greater economies of scale, and thus to lower margins overall. In addition, access to better price information should lead to a more efficient marketing system, and consequently lower overall margins. Finally, changes in food consumption patterns due to income growth may be reflected in higher quality premia if changes in the supply of high quality products do not keep pace with the growing demand for these products. These predictions were tested through various analyses of price behaviour over the last decade.

First, we find that there do exist quality premia among cereals, but that these premia changed little over time. Second, the spatial variation in cereal prices among wholesale markets and the margins between supplying and receiving markets have decreased significantly over time. Third, markets are becoming more spatially integrated as prices co-vary among more markets and as price adjustments take less time. Fourth, retail and milling margins declined by half.

While better road conditions, declining transportation costs, and smaller marketing margins generally result in a better functioning agricultural economy, change inevitably results in both winners and losers. The winners are the suppliers in major production zones, as they receive higher prices on average, while urban consumers in the big cities also benefit from the lower prices that result from lower margins. The losers are likely net consumers residing near to or in the supplying areas, as they might now confront higher prices. Furthermore, producers who reside close to the consuming areas may be worse off, as they now face lower prices. Nonetheless, the net gain for the economy as a whole from such market improvements is likely to be substantial (Gardner, 1975).

While these findings are encouraging for Ethiopia, there is still significant room for market improvement. First, despite the large sums of money invested in road improvements, Ethiopia started from a low base and still has one of the lowest road densities in the world (von Braun & Olofinbiyi, 2007). Second, even when roads are available, transport costs are still relatively high compared to international standards; further measures are needed to reduce transportation costs (Teravaninthon & Raballand, 2009). Third, while access to information is now widely available for traders and brokers, penetration and use of mobile phones by farmers is still one of the lowest in Africa (Nakasone, Torero, & Minten, 2014). Fourth, while modern input adoption has improved considerably, adoption levels, especially of improved seeds, are still low, often because of lack of supply. Finally, food prices in Ethiopia remain highly volatile. This type of price volatility is often linked to the uncertainty associated with ad hoc policy decisions (such as price controls, export bans, and other market interventions), which hamper sustainable private market development.

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Notes

1. The interest in agricultural markets in Ethiopia is reflected in the literature, as a significant body of research exists that has looked at food price related issues in Ethiopia (for example, Dercon,1995; Gabre-Madhin, 2001b; Getnet, Verbeke, & Viaene, 2005; Negassa & Myers, 2007; Rashid, 2011; Tadesse & Guttormsen, 2011; Tadesse & Shively, 2009; Ticci, 2011).
2. One important caveat of our analysis is that the markets that we analyse and for which we have consistent price series mostly serve regional centres. It is well possible that rural markets are more dysfunctional and responsible for famines in rural areas (for papers on famines and market behaviour, see Drèze & Sen, 1989; Ravallion, 1987; Rivers, Holt, Seaman, & Bowden, 1976; Shin, 2010).
3. Producer prices are defined as those prices that are received by producers at the wholesale market; wholesale prices are the prices that wholesalers obtain when they sell in large bulks; retail prices are prices on the wholesale market or in nearby markets obtained by traders that sell in small quantities to consumers.
4. We use a de-seasonalised index. To construct such a de-seasonalised index, we calculated a 12-month moving average and used the constructed series as the deflator.
5. Of the 13 cities with a population over 100,000, two of these cities were not part of the EGTE price series, that is Harar and Awassa.
6. Most of the agricultural seasons in the highlands of Ethiopia (where the majority of the analysed markets are located) are similar, with harvests occurring at the same time. Taffesse et al. (2013), for example, show that 97 per cent of all agricultural production in the country occurs during the Meher season and that the Belg season is of minor importance. We therefore do not include additional market–month interactions in the regression as this would also limit the scope of the spatial price analysis.
7. For a discussion of market transformation and its drivers, see Minot and Roy (2007) and Reardon and Timmer (2007).
8. While urbanisation has led to increased rural–market flows, higher population growth in rural areas has also led to increased demand for marketed food in rural areas. Using the census data of 1994 and 2007, Schmidt and Kedir (2009) estimate that the absolute growth of the rural population (13.7 million) was twice as high as the urban population (6.7 million). However, given that most household food consumption in rural areas derives from own-produced food, it is unlikely that rural

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population growth has had as much of an impact on food marketing flows than has increasing urbanisation, as city dwellers typically depend completely on purchased food.

9. Changes in commercial surplus for cereals appear to be driven mostly by increasing production. CSA's agricultural data indicate that changes in commercialisation rates per farmer have played a small role. Furthermore, because urban populations rely heavily on purchased food, and because rural populations rely mostly on their own production for their food consumption needs, most of the increase in commercial surplus can therefore reasonably be linked to the increasing rural–urban market flows that follow from growing urban demand, despite rapid rural population growth. Unfortunately, no good updated and nationally consistent food consumption data for the major cereals were available at the time of writing this paper and no good inference on the influence of income growth can be made.
10. This trend is consistent with estimates taken from the 1983 and 2007 population censuses. Because of improved infrastructure and because of urbanisation, the population census data show the percentage of people who were connected with cities increased dramatically over the 23-year period between 1983 and 2007. According to Schmidt and Kedir (2009), the percentage of the population that lives further than 10 hours away from a city (more than 50,000 people) decreased from 40 per cent in 1984 to 12 per cent in 2007. Given that a number of large construction projects have continued since the 2007 census, it is safe to assume that this trend has only continued.
11. Ethiopia froze fuel prices between August 2006 and January 2008; it had decreased the price of gasoline in February 2007. In October 2008, it eliminated fuel price subsidies altogether (Kojima, 2009).
12. However, given that they are able to transport between twice or four times the load of the smaller trucks, their share of the total quantity of cereal transported is significantly higher than 13 per cent.
13. While increasing competition in the transport sector is hard to measure, one rough indicator is the increasing number of trucks imported into the country each year. Comtrade data (data on international trade are collected by the UN and can be downloaded from http://comtrade.un.org/), for instance, show that the number of trucks imported in the country doubled between 2001 and 2011. This increase is greater than observed in the wholesale markets. These imports thus illustrate not only the important increases in commercialisation in the country, but likely also reflect other important changes, such as in the construction sector.
14. For those trips where no complete time series could be collected from the group over the whole 10 years, the rest of the series was deleted. Thus, we ended up with 204 consistent price series of transport costs between wholesale markets.
15. While there are questions on the efficacy of this system (Davis et al., 2010), evaluations have shown that access to extension did positively affect agricultural yields (Dercon, Gilligan, Hoddinott, & Woldehanna, 2009) and adoption of improved technologies (Krishnan & Patnam, 2012).
16. From our data, the following markets can then be considered to be situated in major supply zones: Jimma and Nekemt for maize; Assela and Bale Robe for wheat; and Assela for barley.
17. Tests for structural change in the sorghum trade are hampered by missing price information in the first part of the decade. It has therefore been excluded from the analysis.
18. Mekelle is the capital of Tigray region. Tigray is among the poorest and most vulnerable regions in the country, together with the pastoralist regions (MoFED, 2012). Dessie is the capital of the South Wollo zone; the population in this zone has been hit hard by several famines in the past (Graham, Rashid, & Malek, 2012).
19. In the TAR model, unit root behaviour in the transaction cost band is imposed by setting $\rho in=0$. This reduces the estimated model inside the band (if $-\theta t \leq dt-1 \leq \theta t$) from $\Delta dt = \rho in\ dt-1+ \varepsilon t$ to $\Delta dt = \varepsilon t$. Consistent with the TAR model's requirement, all the markets considered for all categories of cereals are tested for a unit root and only those that are non-stationary in level terms and stationary in the price differences for any market pair were considered for the analysis.
20. A market pair is considered integrated when the price adjustment in one market in response to a shock in the other is statistically significant in the TAR model. It is considered well integrated when the estimated adjustment parameter is not statistically different from –1 (that is, prices in the two markets move in step with each other).
21. Unfortunately, we have no data on observed transaction costs between these markets. In the focus group interviews, respondents were asked about average transportation costs over the last year. From this, we find that transportation costs (an important part of the transaction costs) as a share of average annual prices in Addis at the time of the survey were as high as 7 per cent for white teff, 8 per cent for mixed teff, 9 per cent for red teff, 8 per cent for white wheat, 16 per cent for maize, 12 per cent for white sorghum, and 12 per cent for barley. These numbers are close to the transaction cost estimates from the price integration model (based on weekly data) and suggest that the results of the model are mostly consistent with these data (except for sorghum and barley).
22. For example, MoFED (2012) shows that non-farm prices in Addis (mostly rent) are significantly higher than the rest of the country.
23. Such as the ALDI (agricultural-led development industrialisation) and PASDEP (a plan for accelerated and sustained development to end poverty).

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